DOCUMENT RESUME

ED 043 557 SO 000 290

AUTHOR Carswell, Ronald J. B.
TITLE Children's Abilities in Topographic Map Reading.
INSTITUTION Queen's Univ., Kingston (Ontario).
PUB DATE Sep 70
NOTE 13p.; Paper presented at A Symposium on the Influence of the Map User on Map Design, Queen's University, Kingston, Ontario, September 8-10, 1970

EDRS PRICE EDRS Price MF-$0.25 HC-$0.75
DESCRIPTORS *Cognitive Ability, *Elementary School Students, Maps, *Map Skills, Perceptual Development, *Research Reviews (Publications), *Skill Development, Social Studies, Spatial Relationship, Teaching Techniques
IDENTIFIERS *Topographic Maps

ABSTRACT

Although over 40 studies have been done since 1925 on map reading, there is little understanding of children's ability to comprehend maps or the mental processes involved. Children's inability to read maps is well document, as are their improved skills after instruction. Yet map skills are part of the elementary curriculum. Success in teaching map reading skills is overestimated for at least four reasons: 1) an oversimplification of what is involved in reading a map; 2) teaching the wrong things about maps and not using maps in instruction; 3) failure to sequence skill development using large and small scale maps; and 4) ineffectual teaching techniques and omission of field instruction. Research shows that children are capable of using maps more effectively than they now do. Perhaps we do not fully understand the development or operation of spatial abilities. Little theoretical work in this area, with the exception of Piaget, can be applied directly to map learning. It appears that as children move through the elementary grades their spatial abilities are suppressed if not extinguished. One method of encoraging spatial skills appears to be through techniques using large scale topographic maps in the upper elementary grades. Lastly, attention must be given to helping teachers understand maps and techniques of map instruction. (SBE)

U.S. DEPARTMENT OF HEALTH, EDUCATION
& WELFARE
OFFICE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

ED043557

CHILDREN'S ABILITIES IN TOPOGRAPHIC MAP READING*

by

Ronald J. B. Carswell

Department of Curriculum and Instruction

The University of Calgary

There are three major points to be discussed in this paper. First, we overestimate our success in teaching map reading skills. Second, we tend to underestimate the map reading abilities of children. Third, our teaching of map skills mitigates against the operation of spatial mental ability. In short, there is little understanding in the educational and geographic communities of children's ability to comprehend maps or the mental processes children use to decode maps.

This state of affairs is somewhat difficult to understand, considering the volume of available "research" associated with map learning. I have located over 40 studies completed since 1925. The inescapable conclusion arising from study of these is that little increase in knowledge has resulted from 45 years of quasi-experimental research. Many of the studies addressed themselves to the question of, "how well do children comprehend maps?" Those that were not an inventory, concentrated on the teaching of map skills and subsequent increase in

SP 000 290

---

* A paper for presentation during A Symposium on the Influence of the Map User on Map Design to be held at Queen's University, Kingston, Ontario, Canada, from September 8 to September 10, 1970.

map reading abilities. Over 90% of the studies used data collected by paper and pencil instruments. Few of the studies were placed in a theoretical context--educational, geographical, cartographical, or otherwise.

Children's inability to read maps is well documented; as is their ability to improve skills after instruction. Studies by Bartz (1965), Brown (1960), Lord (1928), Millar (1931), Prior (1959), Stampfer (1966), and Young (1952) attest to the low level of map reading ability of children. On the other hand, reports by Carmichael (1965), Carswell (1968), Forsyth (1943), Rushdooney (1961), Starr (1954), and Weinswig (1962), show that comprehension of maps increases after instruction.

Let me refer to my study of topographic map reading skills as an example of this "test-teach-test" type of research which has occurred in the past. In the discussion of this study, an attempt will be made to substantiate the three claims which were made at the beginning of this paper.

The primary purpose of my study was to investigate the topographic map reading and interpretation abilities of students in grades four, five, and six, and the observed changes in these abilities after a period of planned instruction. Other problems investigated included an examination of the relationship that exists between map skills and intelligence, spatial ability, sex differences, socio-economic level, grade level, chronological age, and the teacher's knowledge of geography. An analysis was also made for each grade level of the relative difficulty of attaining each of the six skills necessary to read and interpret a

POOR ORIGINAL COPY - BEST
AVAILABLE AT TIME FILMED

topographic map. These skills were defined as the ability to read symbols, direction, scale, elevation, and grid systems as well as the ability to interpret information from the map.

An experiment was devised which used pre, post, and recall tests for both an experimental and a comparison group. Commercial standardized instruments were used as well as the Test of Topographic Map Skills, which was devised and validated. Further, a linear program keyed to a topographic map of the local area was used to teach the topographic map reading skills as this seemed to be the most effective way to present the skills and ensure equivalence of instruction among different classes.

Fifteen classes were selected in consultation with the Calgary Separate School Board and, at each grade level, four classes were arbitrarily assigned to the experimental group and one to a comparison group. A comparison of the two groups showed that there were no significant differences in map skills or mental ability before instruction.

A major finding of my research is that learners in grades four, five, and six, can learn to use large-scale topographic maps effectively. In each grade there was a significant gain in ability as measured by the test of topographic map skills, while the comparison groups did not make an improvement that was statistically significant.

Figure 1 shows how effectively the children performed on each of the six skills, both before and after instruction. The pretest findings indicate that symbols and direction were the only skills on which an average score of 50% was made. This was only in grades five and six. The attainment of other skills was much lower--especially in the case of

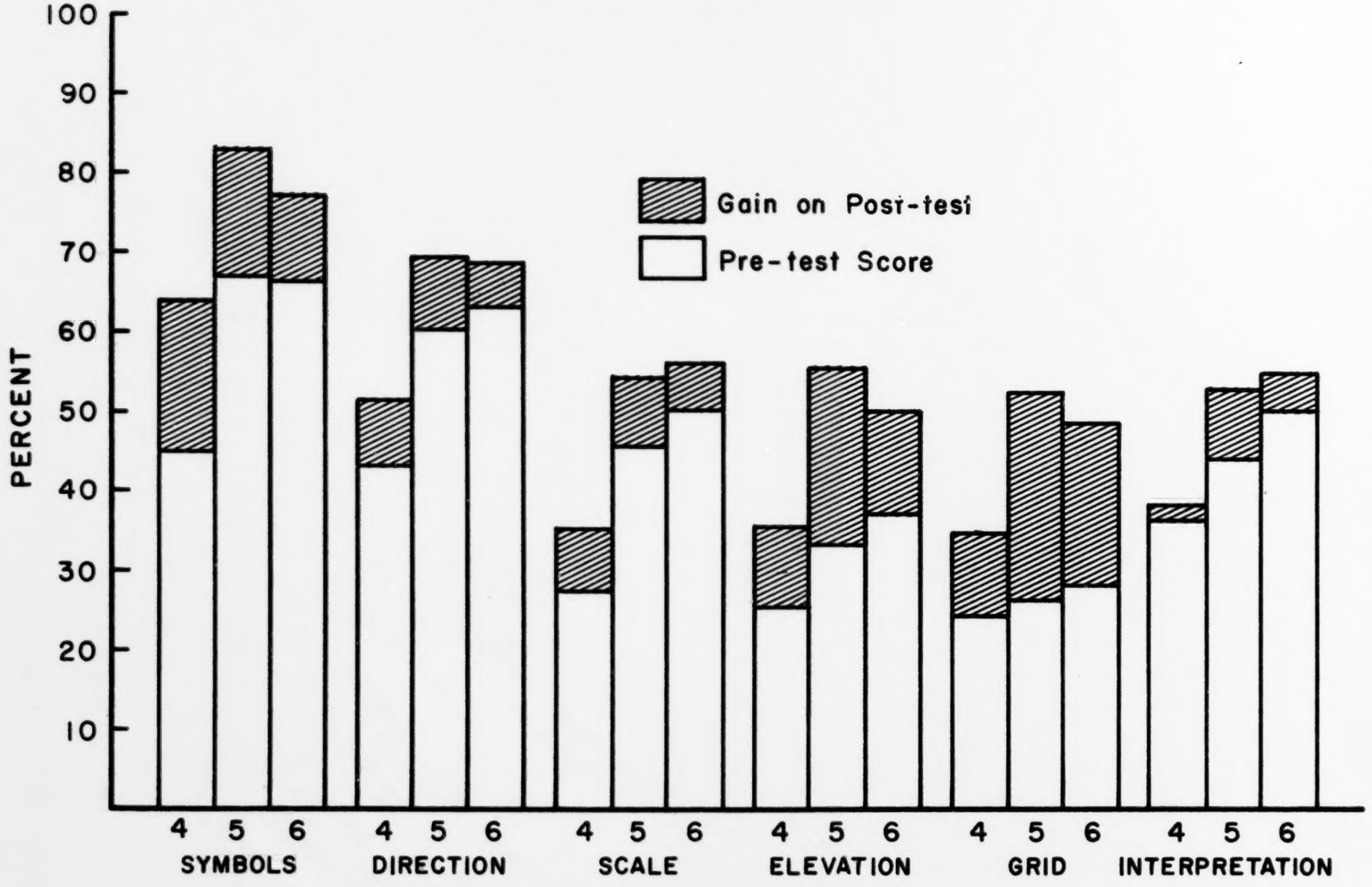

FIGURE 1

MEAN PRE- AND POST-TEST SCORES IN PER CENT ON THE SUBSCALES OF THE TTMS BY GRADE

grid systems. If a score of 80% could be defined as showing mastery of the skill, then none of the grades had mastered any of the skills that were being examined. This supports the research which has been referred to earlier. I am sure that those of you who teach geography at whatever level, could probably give further evidence supporting the low level of map reading achievement among school children and adults.

Yet map skills are a part of our school curriculum. In the elementary grades, much attention, at least according to course outlines, appears to be given to them. Nevertheless, on the whole, children appear to read maps very poorly, consequently, my claim that we overestimate our success in teaching map reading skills.

I think there are at least four reasons, and probably many more, why the educational system has performed so inadequately in teaching map reading skills. First, I suspect that there is a gross oversimplification in the minds of teachers of just what is involved in reading a map. After all, a map is an extremely complicated combination of lines, colors, and symbols, in which reality has been transformed in terms of scale, shape, and perspective.

Secondly, I suspect that the wrong things are being taught about maps. That is, teachers are probably teaching about maps rather than with maps. Children may be learning the characteristics of various types of map projections and perhaps even how these projections are made, rather than using maps as a means to solve problems or to help them get a more accurate impression of the landscape. Third, I suspect that there is something lacking in the sequencing of map skills. In the

primary grades, children work with large scale maps of their classroom, school, and neighborhood. Suddenly, in grades three or four, they are working with small scale maps of their province, country or world. The use of large scale maps after grades two or three seems to be sadly neglected.

It is surprising the kinds of misconceptions that children can develop when they attempt to make some sense out of large scale maps when they have been working primarily with small scale maps. For instance, I was using a topographic map in a clinical situation with a grade four pupil. I asked her to identify the trans-Canada highway which ran across the middle of the map. Her response indicated that this red line, which more or less divided the map in half, was the equator. It is easy to see why this would happen, but it does not condone the fact that it did happen.

Fourthly, the techniques which are used to teach mapping skills seem to be ineffectual if they exist at all. In many cases, the teacher seems to assume that children can read a map. Certainly, there is little attention given to the discreet skills which are needed to make maps comprehensible. It also appears that few attempts are made to take children out into the field and have them learn to use a map through relating it to the reality which they can see.

The work of Barbara Bartz, in attempting to make small-scale maps more comprehensible to children, is firmly based on the assumption that children are going to get very little instruction in map skills. This is a commendable way of helping children read maps, but it does not

solve the basic problem of improving the teaching of map skills. On the other hand, the exploratory work of Blaut (1969) and others at Clark University is necessary to develop an approach to helping children learn to use maps more effectively.

The results of the post test as indicated in Figure 1 support the contention that we tend to underestimate the map reading abilities of children. Overall the experimental group made a 25% increase as measured by the TTMS. Among the grades and skills, this ranged from a 110% increase by grade five in dealing with grid systems to an 8% increase by grade four in ability to interpret maps. It appears that symbols and direction are the least difficult skills and that they may be mastered in the intermediate grades; scale, grid system, and elevation seem to be of equal difficulty and may be learned and used, even though not mastered in the intermediate grades. Interpretation appears to be a complex skill which showed little increase in this experiment. Probably techniques other than the use of a linear program would be necessary to help children increase their interpretation abilities. Not only was there an increase in the children's ability to use these skills, but a recall test given approximately one month after the final test showed that the competencies they had gained had not diminished.

These findings and the earlier mentioned research show that children are capable of using maps more effectively than they now are doing. Certainly, a review of the literature available to teachers, shows that most writers who have considered the use of topographic maps in school would place them at the junior high school level, because of

their complex nature. Few, if any, educators would suggest the use of vertical areal photographs as substitutes for maps in the early grades. Yet the work of McDermott (1966), Kingston (1968), and Blaut (1969) illustrates that children from kindergarden to grade three are capable of understanding and getting meaning from large scale vertical areal photographs. As information accumulates from these types of clinical studies, there should be considerable impact on the teaching of map reading skills.

Perhaps the teaching of map skills is poorly understood because we do not fully understand the development or operation of spatial ability in humans. Although psychologists have been concerned about spatial ability as an aspect of intelligence, there is little theoretical work, with the exception of Piaget (1956), which can be applied directly to map learning. Piaget's experiments related to development of topologic, geometric, and projective space may be closely related to map skills. The results of his studies of the development of the concept of coordinate systems and the ability to understand and use perspective seem to relate closely to children's ability to use maps. Much more research is needed in this area and theories may be developed which diverge from those of Piaget. Nevertheless, his work provides us with one framework for examining mapping skills and their relation to space representation.

This brings us to my final contention. That is, whatever passes for the teaching of map reading skills in elementary schools is having a deleterious effect on the development of spatial abilities. Reference

to Figure 2, "Correlations and Partial Correlations Between Scores on the TTMS and Scores on the California Tests of Mental Maturity," will provide some justification for this statement.

The correlation of mental age and the partial correlations of verbal mental age, nonverbal mental age and spatial ability with the scores on the TTMS are shown for the total sample and by grade. You will note that the partial correlations with verbal mental age are higher than those for nonverbal mental age or spatial ability. However, there are two most interesting things to note. First, in most cases, the partial correlations with verbal mental age tended to decrease while the partial correlations with nonverbal mental age and spatial ability tended to increase after instruction. Secondly, from grades four to six there is an increase in the partial correlation with verbal mental age and a decrease in the partial correlation with nonverbal mental age and spatial ability.

Since my sample worked with a linear program and used a paper and pencil test, we might expect a high correlation with verbal mental age. Yet studies by Edwards (1953), Taylor (1960), and Smith and Taylor (1967) support my findings. Taylor (1960, p. 270) went so far as to suggest that on the basis of factor analysis there was no evidence that spatial ability entered into attainment in geography as measured by school examinations or objective map tests which he had prepared.

From this I would conclude that as children move through the elementary grades their spatial abilities are supressed if not extinguished. One method of encouraging the use and development of spatial

FIGURE 2

CORRELATIONS AND PARTIAL CORRELATIONS BETWEEN SCORES ON THE T.T.M.S. AND SCORES ON THE CALIFORNIA TESTS OF MENTAL MATURITY

	Mental Age	Verbal Mental Age[1]	Nonverbal Mental Age[2]	Spatial Ability[3]
Total Sample (Pre)	.631*	.494*	.286*	.233*
Total Sample (Post)	.630*	.449*	.319*	.259*
Grade 4 (Pre)	.641*	.348*	.381*	.347*
Grade 4 (Post)	.578*	.266*	.347*	.298*
Grade 5 (Pre)	.530*	.386*	.342*	.273*
Grade 5 (Post)	.498*	.327*	.346*	.295*
Grade 6 (Pre)	.452*	.429*	.143	.061
Grade 6 (Post)	.565*	.484*	.249	.171

* Significant at .01 level
1 nonverbal mental age held constant
2 verbal mental age held constant
3 verbal mental age held constant

skills appears to be through techniques using large scale topographic maps in the upper elementary grades.

There are two major conclusions that I wish to draw related to map design. First, since children are capable of using complex maps such as the 1:50,000 topographic series, maps do not need to be severely modified for school use. Granted, Canadian topographic maps could communicate more effectively with children if, among other things, they did not have four coordinate systems and if the linear scale were modified to begin at zero. However, these are minor changes.

Secondly, children's inability to use maps seems to be less related to map design than related to ineffective teaching. Most elementary teachers that I have observed in Alberta, British Columbia, Colorado, and Florida did not seem to have learned from their geography or education courses how to use or effectively teach about maps. Consequently, attention must be given to helping teachers understand maps and techniques of map instruction. I expect that this is done more effectively in Ontario than in some other places because of your long tradition of instruction in geography.

Through a combination of the modification of present map design and improved instructional techniques, children should become even more effective map users.

BIBLIOGRAPHY

Bartz, B. S. Map design for children. Unpublished manuscript, Chicago: Field Enterprises Educational Corporation, 1965.

Blaut, J. M. (Ed.) Place perception research reports. mimeographed, Clark University, 1969.

Brown, T. W. Report of a discussion on mapwork and the use of maps in schools. Geography, 1960, 45, 305-307.

Carmichael, D. R. Developing map reading skills and geographic understandings by means of conceptual teaching. Unpublished doctoral dissertation, University of California, Berkeley, 1965.

Carswell, Ronald J. B. Topographic map reading abilities of learners in grades four, five and six. Unpublished doctoral dissertation, University of Florida, 1968.

Edwards, J. H. An analysis of the aspects of space involved in the teaching and learning of geography in the intermediate grades. Unpublished doctoral dissertation, University of Pittsburgh, 1953.

Forsyth, E. An experiment in the teaching of certain map reading skills at the junior high level. Unpublished doctoral dissertation, Cornell University, 1943.

Kingston, Beatrice E. Reading and interpreting vertical aerial photographs in the primary grades. Unpublished master's thesis, The University of Calgary, 1969.

Lord F. E. The ability to make geographic uses of the ideas of latitude and longitude. Unpublished master's thesis, University of Chicago, 1928.

McDermott, Paul D. Preliminary investigation of the suitability of aerial photographs for developing visualization and comprehension of map symbols. Unpublished master's thesis, University of Washington, 1966.

Millar, G. J. Testing map reading ability. Journal of Geography, 1931, 30, 38-42.

Piaget, J. and Inhelder, E. A child's conception of space. London: Routledge and Kegan Paul, 1956.

Prior, F. M. The place of maps in the junior school. Unpublished thesis for the diploma in child psychology, University of Brimingham, 1959.

Rushdooney, H. A. A study of relationships between achievement in map-reading and selected factors. Unpublished doctoral dissertation, University of California at Berkeley, 1961.

Smith, I. M. and Taylor, C. C. A factorial study of an hypothesis about the nature of spatial ability. The Durham Research Review, 1967, 5, 149-166.

Stampfer, N. A study of map skills attainment in selected middle grades. Unpublished doctoral dissertation, Northwestern University, 1966.

Starr III, J. S. A comparison of two methods of teaching map-reading skills at the intermediate grade levels. Unpublished doctoral study, Colorado State College, 1954.

Taylor, C. C. Summary of research reported in degree thesis: A study of the nature of spatial ability and its relationship to attainment in geography. British Journal of Educational Psychology, 1960, 30, 266-270.

Weinswig, S. E. Evaluation of lessons to teach introductory map skills in grade four. Unpublished doctoral dissertation, Boston University, 1962.

Young, C. V. An experimental investigation into children's comprehension of school atlas maps. Unpublished master's thesis, University of London, 1952.